United States Department of Agriculture

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Montana
Natural Resources Conservation Service
Soil Health Project Reports 2016

Bozeman Area

Welcome to the 2016 project reports from the Bozeman Area Soil Health (BASH) team. We hope that this document will be a useful tool for farmers, NRCS staff, and researchers. These eight reports are the field observations and measurements we made during the 2016 growing season. Keep in mind these are not replicated or repeated scientific trials. They are simply our best attempt at reporting what we saw in the field in one growing season.

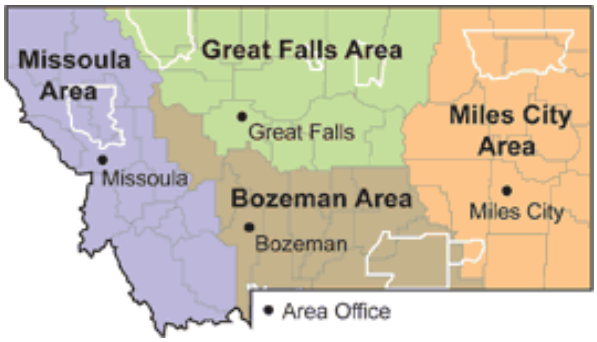


Fig. 1. Montana NRCS Areas.

Montana NRCS is divided into four administrative areas. The Bozeman Area consists of twelve counties and thirteen field offices, noted in brown in Fig. 1. This document is only from projects observed in the Bozeman Area.

In 2016, the BASH team consisted of eleven NRCS staff in the Area. Our mission is to promote NRCS's five main soil health principles throughout the Area. These principles include:

1. Minimize soil disturbance
2. Keep the soil armored (residue management)
3. Keep a living root in the soil
4. Increase crop diversity
5. Integrate livestock grazing

Use of these principles over time should result in increased soil organic matter and functioning, which is the key objective of improving soil health. Any project in the area that included one or more of these principles was eligible for inclusion in this report.

All projects were located on actual farms, and all field work was done by actual farmers. NRCS's role was to simply observe, measure, and report what we saw in the field. The choice of which projects to report was mainly based on the existing relationships that staff have with farmers in the Area.

For consistency and comparison across the Area, all AUM calculations use the assumption of 910 lb of forage per month for every 1000 lb animal unit, and that 50% of the forage is grazed and 50% is left in the field. All growing degree day (GDD) calculations used 40F as the base, with no upper temperature limit. GDD calculations were done with the online calculator at http://uspest.org/cgi-bin/ddmodel.us, using the same weather coop station used to report the monthly rainfall. Monthly rainfall measurement tables all come from the Western Regional Climate Center website, www.wrcc.dri.edu. The reported average annual precip amount is based on PRISM data and located in maps in section I of the Field Office Technical Guide (FOTG). Biomass was measured by clipping as close to the soil surface as possible, but did not include the tops of radish or turnip root fragments. All dried biomass was air-dried at the nearest field office.

We hope these reports will be informative and useful as we all learn more about the best ways to improve soil health across the Bozeman Area.

Sincerely, The 2016 BASH Team

Susan Tallman – lead, Bozeman Area Agronomist
Evan Van Order – Hardin, MT
Kristin Fletcher – Bozeman Area Cartographer
Chuck Roloff – Big Timber, MT
Jenney Paddock – White Sulfur Springs, MT
Darcy Goodson – Helena, MT
Ted Nelson – Columbus, MT
Chris Mahony – Bozeman, MT
Scott Anderson – Roundup, MT

Table of Contents

Irrigated Cover Crop under Sodic Conditions near Columbus

Mark Doely, NRCS Soil Conservation Technician, Columbus MT 2016

County: Stillwater, near Columbus
Average Annual Precip: 15”
MLRA: 58AC,
Dominant Soil Type: Havre loam, Lardell clay loam 0-2% slopes
Acres: 164
Planting Date: July 11, 2016
Seeding Method: Single-disk planter
Row Spacing: 7”
Tillage: Plowed fall 2015, disk ripper before planting.
Previous Crop and Year: Grass and alfalfa hay (2015)
Hay Barley spring (2016)
Fertilizer: Used for spring hay barley
Irrigation: Center pivot/flood
Next Crop: Alfalfa (2017)

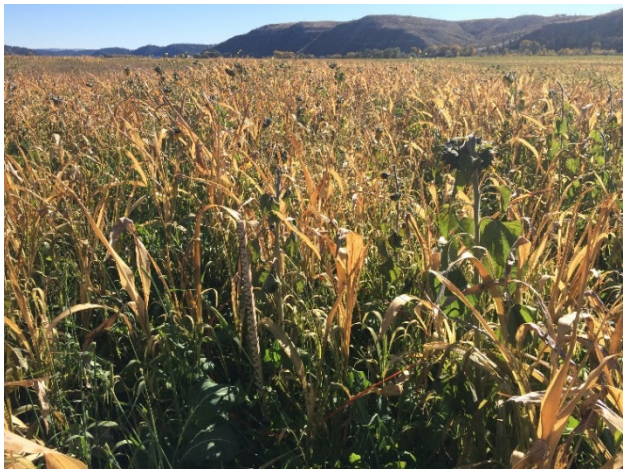


Fig. 1. Cover crop on Oct 12, 2016. Note yard stick in foreground.

Monthly Precipitation at Columbus, MT

	J	F	M	A	M	J	J	A	S	O	N	D	Total
30 yr. avg. 1981-2010	0.61	0.67	1.08	1.85	2.69	2.27	1.18	0.93	1.31	1.19	0.64	0.57	14.99
2015	0.91	0.57	0.32	1.40	4.19	1.14	0.59	1.38	0.27	1.85	0.82	0.98	14.42
2016	0.17	0.04	0.97	1.29	3.12	0.41	2.17	1.29	2.03	2.93	0.46	1.69	16.57

Fig. 2. Monthly precipitation at Columbus, MT. Western Regional Climate Center, station #241938.

Introduction: The fields the producer seeded the cover crop into were previously in an old alfalfa/grass stand. They were looking for forage for fall grazing and also something that would possibly take up excess moisture in portions of the field. It was determined that around 11% of the field was sodic. The field is close to the Yellowstone River, with a high water table. Salts are wicked upward through the soil profile. NRCS staff suggested that leaching via irrigation plus increasing organic matter via crop residues and manure would be the best way to treat this. The producer had plowed the field in the fall of 2015 and used a disk ripper before planting spring hay barley in 2016, the hay barley was harvested the last week of June and the cover crop seeded July 8-16. The producer used a disk ripper to prepare the field before the cover crop. NRCS had suggested spraying the field to leave the residue but the producer was trying not to use any chemicals on his fields.

Results: The cover crop established well except in the sodic areas of the field. The warm season grasses (sorghum-sudan and German millet), sunflowers, turnip, and collards all performed well. The volunteer barley made a nice addition to the mix as well. However, in areas of the field where warm-season grasses had run out of the drill, the volunteer barley dominated the stand. The one species that did not perform well was the soybean, with few plants observed in the field. Sampling was conducted on October 12th. Four different 4.8 ft^2 hoops were clipped but only two clippings were reported as they better represented the part of the field where hay barley did not dominate. It was determined that approximately 8.7 acres had no growth due to the sodic conditions. There were 2265 Growing Degree Days (base 40) from the average date of seeding (July 11) to the sampling date (Oct 12) (Columbus Coop site). Total above ground biomass after air drying was 5,040 lb per acre. Using a harvest efficiency of 50% for grazing and allowing 915 lbs/AUM results in 2.8 AUMs of grazable forage per acre, or 435 AUMs on 155 acres.

	Pounds of seed per acre	Percent of total seed number	Percent of total biomass production
Soybean	4	1	0
Radish (Graza)	1	2	2
Warm-season grasses (Sorghum-sudan and German millet)	7.5 3	13 51	48*
Sunflower	2.5	1	24
Turnip (Purple top)	1	16	10
Collards (Impact)	1	16	5
Volunteer hay barley	-	-	10

*Fig. 2. Cover crop seed mix and production, 2016. *Millet and sorghum-sudan were not separated at sampling.*

Summary and Discussion: The producer was pleased with the results of the cover crop seeding. The cover crop was competitive enough to not be dominated by hay barley, however, seeding issues caused uneven distribution of plants throughout the field and barley dominated in areas that had lighter seed distribution. The producer used cattle to graze the cover crop in late October and was pleased with the results. The cover crop did not establish in the sodic areas. Future management should include intensive feeding on those areas to work in plant material through hoof action and provide supplemental manure. The more organic matter that can be applied to these areas the better. In addition, care should be taken to use enough irrigation to flush salts down into the soil profile. The producer was happy with the results of the cover crop and has plans in the future to renovate some other hay fields that would use the same hay barley, cover crop rotation.

Fig. 3. Earthworms and castings observed throughout the non-sodic parts of the field, Oct 12, 2016.

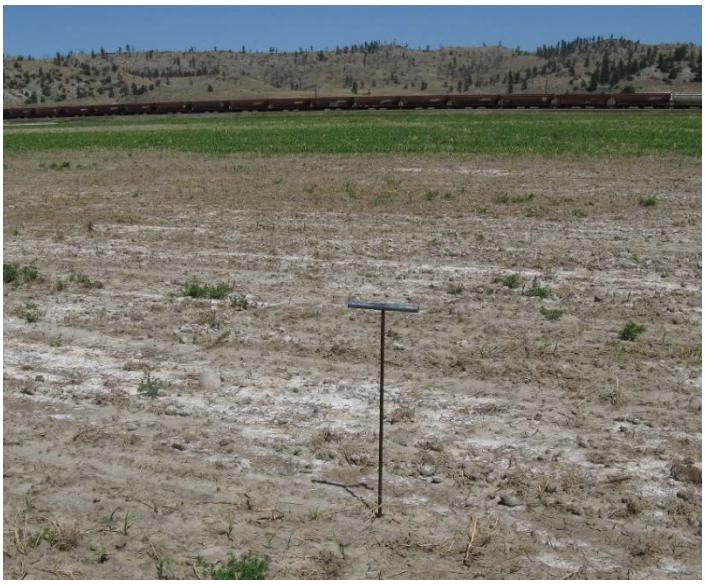


Fig. 4. Sodic area of the field three weeks after seeding cover crop, Aug 4, 2016

Cover Crop Following Malt Barley near Park City

Garrett Larson, NRCS District Resource Conservationist, Columbus MT 2016

County: Stillwater, near Park City
Average Annual Precip: 14”
MLRA: 58A, Northern Rolling Plains, Northern Part
Dominant Soil Type: Glendive fine sandy loam, 0-4% slope
Acres: 67.5
Planting Date: Aug 6, 2016
Seeding Method: Double-disk planter
Row Spacing: 7”
Tillage: Transitioning to no-till
Previous Crop and Year: Silage corn (2015)
Malt barley (2016)
Fertilizer: Fertilized prior to barley
Irrigation: Center pivot
Next Crop: Alfalfa (2017)

Fig. 1 Cover crop with radish, Sept. 2016.

Monthly Precipitation at Columbus, MT

	J	F	M	A	M	J	J	A	S	O	N	D	Total
30 yr. avg. 1981-2010	0.61	0.67	1.08	1.85	2.69	2.27	1.18	0.93	1.31	1.19	0.64	0.57	14.99
2015	0.91	0.57	0.32	1.40	4.19	1.14	0.59	1.38	0.27	1.85	0.82	0.98	14.42
2016	0.17	0.04	0.97	1.29	3.12	0.41	2.17	1.29	2.03	2.93	0.46	1.69	16.57

Fig. 2. Monthly precipitation at Columbus, MT. Western Regional Climate Center, station #241938.

Introduction: The producer has recently begun to implement soil health activities on his operation. These activities include reduced tillage and the movement towards no-till, as well as the addition of cover crops to his cropping rotation. His rotation is silage corn - malt barley - alfalfa (5 yrs). Center pivot irrigation helps facilitate the implementation of these activities. This cover crop was seeded after barley harvest to add diversity to the cropping rotation as well as provide supplementary fall and winter grazing.

Species	Seeding Rate (lb/ac)	Percent of total seed number
Turnip (Purple Top)	0.6	18
Millet (Pearl)	1.5	21
Radish (Tillage)	0.2	1
Soybean	6	3
Sunflower	1.6	2
Sorghum-sudan grass	3.75	12
Lentil	5	19
Safflower	1.5	4
Buckwheat	4.8	15
Hairy Vetch	2	4
Total	**27.0**	

Fig. 3. Cover crop seed mix.

Results: The cover crop did establish. However, the warm season species (millet, soybean, sunflower, and sorghum-sudan) struggled due to being seeded towards the end of the warm season growing window and heavy competition from volunteer barley. These species were observed in the field earlier in August, but estimated to be only about 5% of the biomass. The volunteer barley really came in strong in September. Sampling was conducted on Nov. 17th. Three 4.8 ft^2 hoops were clipped at random sites across the field. Clippings were not separated by species due to time constraints. There were 1893 Growing Degree Days (base 40) from the time of seeding (Aug. 6th) to the sampling date (Nov 17th) (Columbus Coop site). Total above ground biomass after air drying was 3,893 lbs/ac. We estimated that over 75% of the biomass was volunteer barley. Using a harvest efficiency of 50% for grazing and allowing 915 lbs/AUM results in 2.1 AUMs of grazable forage per acre, or 142 AUMs on 67.5 acres. The field was grazed in November after sampling. The producer was not able to leave much residue after grazing, as they do not have a drill with enough down-pressure to seed into a large amount of residue the next spring.

Summary and Discussion: The producer was pleased with the results of the cover crop seeding, however because volunteer barley dominated the biomass, it is questionable if the cost of the cover crop seed provided a positive economic return. When cover crops are seeded following small grains with no chemical burn down pass between the two, the volunteer small grains provide too much competition for a fully successful cover crop seeding. Producers should keep their goals in mind prior to planting a cover crop. Is the goal cost-efficient production, or is it plant diversity? Both are worthy goals. However, if the goal is cost efficient production, it might be best to simply let the barley volunteer after harvest. In contrast, if the goal is plant diversity, it would be best to spray out the volunteer barley prior to seeding a cover crop. Buckwheat was present in the cover crop mix. It should be noted that NRCS does not recommend using buckwheat in a cover crop within two years of small grain harvest, as this can contaminate grains bound for Asian export markets and can be rejected by grain buyers.

Fig. 4. Cover crop growth on Sep, 2016. Note the predominance of volunteer barley.

Short Season Dryland Forage Crop, Meagher County

Jennifer Paddock, Meagher County District Conservationist 2016

County: Meagher
Average annual precip: 14”
MLRA: 44B Central Rocky Mountain Valleys
Dominant Soil Type: 458C Reedwest-Bacbuster complex, 2 to 8 percent slopes
Acres: 17
Planting Date: May 25th, 2016
Seeding Rate: 44 lb/acre
Seed cost: $32.29/acre
Tillage: some tillage
Previous Crop and Year: Crested wheatgrass
Herbicides: Pre: burndown herbicide in April
Insecticides/Fungicides: none
Fertilizer: none
Irrigation: None
Termination Date: August, 2016
Termination Method: Hayed
Next Crop: Wheat

Fig. 1. Clipping cover crop August 10th, 2016.

Monthly Precipitation at White Sulphur Springs, MT

Roundup	J	F	M	A	M	J	J	A	S	O	N	D	Total
15 yr avg 2001-2016	1.68	0.27	.64	1.37	1.97	2.45	1.27	1.24	1.20	0.92	0.41	0.39	13.82
2015	0.17	0.26	0.20	1.13	2.16	1.30	1.77	0.27	1.30	0.53	0.53	0.97	10.59
2016	0.12	0.08	0.60	0.94	2.03	1.13	1.78	0.58	2.57	1.6	.05	0.37	11.85

Fig. 2. Monthly precipitation at White Sulphur Springs, MT. Western Regional Climate Center, station #243403.

Introduction:

Meagher County is located at high-elevation for crop production, with most of the county over 5000 ft. This field was at 5400 feet. Cool season crops do best here, and very few native warm-season grasses exist in the rangeland. This field was previously in crested wheatgrass, with the producer wanting to return it to annual crop production. This mixed species was planted as an annual forage crop for haying, giving the producer an additional spray window in early April, prior to a late May planting. Ideally, for increased soil health the field would be grazed, with more plant residues left than haying. However, the main purpose of this forage crop was to help with crested wheatgrass removal and prepare the seedbed for annual crops. The field will be in annual crop production in 2017. Some tillage does occur on the field.

Results:

Crop was sampled on Aug 9, 2016. There were 66 growing days from the time of seeding to the time of clipping, with 1843 growing degree days (base 40) in the same period (GDD site close to Springdale Colony). Four clippings were taken in soil type 458C. Plants were air-dried at the office. Total aboveground biomass after air-drying was 2,700 lb/ac (1.3 tons) or 1.5 AUM/ac. Assuming 915 lbs of forage per animal month, and 50% utilization rate on 17 acres, there were 25 AUMs available in this field.

Summary and Discussion:

The producer hayed the field mid-August and got 1 bale per acre, with each bale roughly weighing 1 ton. Peas, turnips, safflower, and triticale did well. The forage crop had some re-growth that was grazed in the fall.

Fig. 3 and 4. Cover crop August 10th 2016 just before clipping

Species Planted	Variety	Performance
Spring Triticale	Taza	Good
Sorghum Sudan grass	Grazex BMR 718	Poor
Turnip	Purple Top	Good
Safflower	Finch	Fair
Peas	Arvika	Good
Forage Collard	Impact	Good
Oats	AC Mustang	Good
Annual sunflower	VNS	Good

Fig. 5. Species visual performance.

Irrigated Cover Crop for Grazing, Meagher County

Jennifer Paddock, Meagher County District Conservationist 2016

County: Meagher
Average annual precip: 14”
MLRA: 44B Central Rocky Mountain Valleys
Dominant Soil Type: 327 A Mussleshell loam 0-2% slopes
Acres: 85
Planting Date: June 10th, 2016
Seeding Rate: 39 lb/acre
Seed cost: $21.73/acre
Seeding Method:
Row Spacing:
Tillage:
Previous Crop and Year: Hay barley (2015)
Herbicides: Pre: None
Post: Broadleaf herbicide applied in August to control mustard
Insecticides/Fungicides:
Fertilizer: none
Irrigation: Pivot sprinkler irrigation
Termination Date: Sept 20th, 2016
Termination Method: Grazing
Next Crop: Hay barley (2017)

Fig. 1. Cover crop August 9th, 2016.

Monthly Precipitation at White Sulphur Springs, MT

Roundup	J	F	M	A	M	J	J	A	S	O	N	D	Total
15 yr avg 2001-2016	1.68	0.27	.64	1.37	1.97	2.45	1.27	1.24	1.20	0.92	0.41	0.39	13.82
2015	0.17	0.26	0.20	1.13	2.16	1.30	1.77	0.27	1.30	0.53	0.53	0.97	10.59
2016	0.12	0.08	0.60	0.94	2.03	1.13	1.78	0.58	2.57	1.6	.05	0.37	11.85

Fig. 2. Monthly precipitation at White Sulphur Springs, MT. Western Regional Climate Center, station #243403.

Introduction:

This location is at high elevation for crop production, near 5000 ft, where cool-season plants dominate the native range. His main goal is to extend the grazing season in the fall, when the cows have returned to home pastures, and to provide soil health benefits from grazing. This cover crop was planted on an irrigated alfalfa field during the renovation phase to provide fall grazing.

Results:

Visited July 21, 2016. Cover crop growing well, but weedy mustard was growing even better. Because of concern of the mustard going to seed a broadleaf herbicide was applied on August 3rd. Clipping was completed on Aug 9, 2016. There were 66 growing days from the time of seeding to the time of clipping, with 1241 growing degree days (base 40) in the same period (WSSM Agrimet station). Four clippings were taken in soil type 327A. Plants were air-dried at

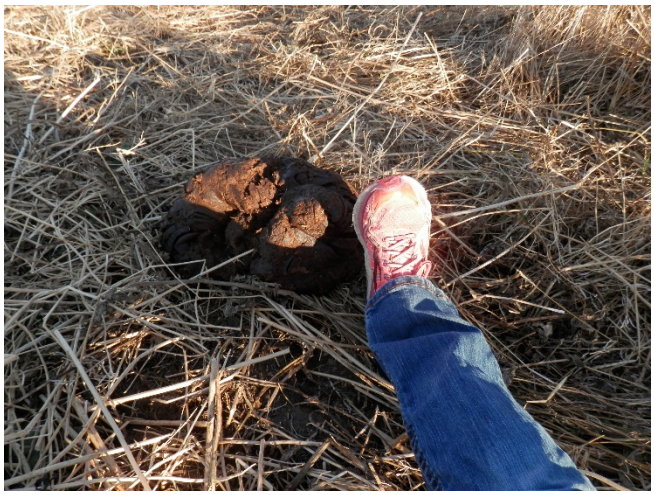
the office. Total aboveground biomass after air-drying was 5850 lb/acre, or 2.9 tons/acre. Assuming 915 lbs of forage per animal month, and 50% utilization rate on 85 acres, there were 273 AUMs available in this field, or 3.2 AUMs per acre.

Summary and Discussion:

The biggest lesson learned in the irrigated trial is importance of using a burndown herbicide prior to planting. Because of the diversity of species, there are limited herbicide options once the stand is seeded. Weedy mustard reduced the overall productivity of this cover crop, decreased the amount of good forage, and limited what can be planted the following year. Broadleaf herbicide application on August 3rd decreased the forage potential for this field. Not surprisingly, sorghum-sudangrass did not perform well in this cool climate.

180 cows were turned in to graze on Sept 20th. Cows appeared to do well on the mix but the amount of grazing provided was less than the producer hoped for due to low quality from high carbon residue. These cattle were new to cover crop grazing and walked the perimeter of the field for days until they started to graze the cover crop. There was sufficient grass and alfalfa in the same field to allow the cattle other forage choices and become slowly acquainted with this new forage.

The broadleaf herbicide may have continued to kill broadleaf plants after our clipping, further reducing the amount of desired forage. By November 9th cattle had removed the high quality portions of the plants such as seed heads, turnip and radish tubers, but there was still lots of high carbohydrate material such as stems. Rather than return to alfalfa in 2017, the producer will plant hay barley to allow an additional year for mustard control.



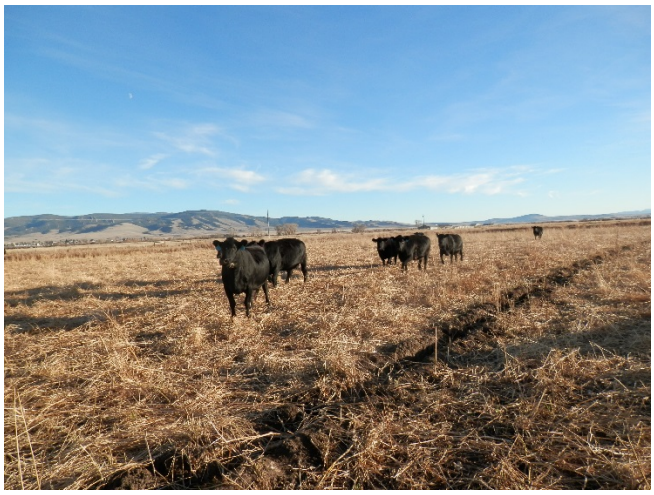


Fig. 3 and 4. Cover crop towards end of grazing, November 8th 2016. Quantity left but quality is gone. Herbicide likely killed forage kale and turnips that would have helped extend the quality.

Species Planted	Variety	Performance
Spring Triticale	Taza	Good
Sorghum Sudan grass	Grazex BMR 718	Poor
Turnip	Purple Top	Good
Safflower	Finch	Fair
Peas	Arvika	Good
Forage Collard	Impact	Good
Oats	AC Mustang	Good
Annual sunflower	VNS	Good

Fig. 5. Species visual performance.

Irrigated Cover Crop for Grazing near Wilsall

Ted Nelson, Park County NRCS District Conservationist 2016

County: Park
Average annual precip: 11”
MLRA: 44
Dominant Soil Type: 248B, cobbly clay loam
Acres: 5
Planting Date: June 10, 2016
Seeding Rate: 22.2 lbs/acre
Seed cost: $20.14/acre
Seeding Method: JD 8300 DD
Row Spacing: 7”
Tillage: Sweeps then again w/ rod weeder
Previous Crop and Year: Malt barley (2015)
Herbicides: Pre: 1.5 qt glyphosate/ac
Post: None
Insecticides/Fungicides: None
Fertilizer: None
Irrigation: Center Pivot, 10-12”
Termination Date: Cows turned in Oct. 4th
Termination Method: Frost, grazing
Next Crop: Malt barley (2016)

Fig. 1. Cover crop on August 9, 2016.

Monthly Precipitation at Wilsall, MT

Wilsall	J	F	M	A	M	J	J	A	S	O	N	D	Total
15 yr avg 2002-2016	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	11.12
2015	0.54	0.37	0.54	1.79	1.89	1.07	1.61	0.45	0.84	1.61	0.92	0.83	12.46
2016	0.31	0.28	0.69	0.99	1.50	0.89	2.09	0.44	2.44	1.49	0.32	0.68	12.12

Fig. 2. Monthly precipitation at Wilsall, MT. Shields Valley AgriMet station near Wilsall, MT.

Introduction:

This was a field that has been in malt barley in recent years. The producer wanted to try a multi-species cover crop in a 5 acre strip in the center of the field to be used for grazing. The species mix would not only provide forage but also benefit the soil by introducing more broadleaf plants and warm-season grasses. The Shields Valley is notorious for a limited growing season with freezing conditions possible in every month of the year. Small grains and hay are the most common crops successfully grown in the valley.

Results:

Visited the field on August 9, 2016 and the cover crop was actively growing and vigorous with all species observed in varying amounts except the kale. Three random clippings were taken on September 16, 2016, and dried and separated by species. There were 98 days between seeding and sampling, with 1920 growing degree days (base 40) during this same period (Shields Valley AgriMet). The average production from the clippings was 6068 lbs of dry matter per acre. Using a harvest efficiency of 50% for grazing and allowing 915 lbs/AUM results in 3.3 AUMs of grazable forage per acre or 16.6 AUMs for the 5 acres planted. At $30.00/AUM, the forage value is about $100/acre.

Summary and Discussion:

Overall, this cover crop grew well but triticale, a cool-season grass, dominated. Triticale was only 20% of the seed mix but produced 72% of the biomass. The effort to introduce warm season species to the field was mildly

successful but broadleaf plants did not flourish in general. We are unsure if any herbicide residual activity caused the lack of broadleaf growth. We were pleasantly surprised to see the presence of millet (warm-season grass) in this cool climate, but disappointed that the forage kale did not grow as planned. The cover crop was grazed in the fall and the producer was pleased with the results. However, for the future, they are weighing the opportunity cost of the lost malt barley income to determine optimum profitability.

The triticale had seed heads, but was still in early dough stage. Information from Canada suggests that late milk to early dough stage is the optimum time to hay triticale for maximum forage balance of protein and carbohydrates (Triticale for Grazing and Hay). However, it may be difficult to hit this optimum timing. For future cool-season mixes for fall grazing in this location, it may be better to delay planting until July when daylength has decreased. This may allow the cover crop to remain in the vegetative phase, allowing for a wider grazing window.

Soil health-building practices have an important place in the Shields Valley but climatic conditions may dictate the mix composition that will be successful. Native rangeland in the area is dominated by cool-season plants. Consideration should be given in future cover crop mixes to limit the amount of cool-season grasses to improve plant diversity in the mix and overall crop rotation.

Fig. 3. Cover crop on September 16, 2016.

Cover Crop	Percent of total seed number	Dry matter production (lb/ac)	Percent of total biomass production
Spring Forage Peas (4010)	24	78	2
Triticale (Trical 141)	20	4380	72
German Millet	32	1286	21
Turnip (Purple top)	6	Trace	Trace
Forage Kale (Bayou)	6	0	0
Sunflower (Peredovic)	4	324	5
Safflower (Finch)	8	Trace	Trace

Fig. 4. Cover crop seed mix and production, 2016.

Irrigated Cover Crop for Grazing in Shields Valley

Ted Nelson, Park County NRCS District Conservationist 2016

County: Park
Average annual precip: 11”
MLRA: 44
Dominant Soil Type: 48B, Clay Loam
Acres: 12 ac.
Planting Date: June 28, 2016
Seeding Rate: 22.2 lbs/acre
Seed cost: $20.14/acre
Seeding Method: JD 8300 DD
Row Spacing: 7”
Tillage: Spike 2X, Disc 2X
Previous Crop and Year: Grass/Alfalfa
Herbicides: Pre: None
Post: None
Insecticides/Fungicides: None
Fertilizer: None
Irrigation: Center Pivot, 5”
Termination Date: Cows turned in Oct. 4th
Termination Method: Frost, grazing
Next Crop: Different CC or grain for forage

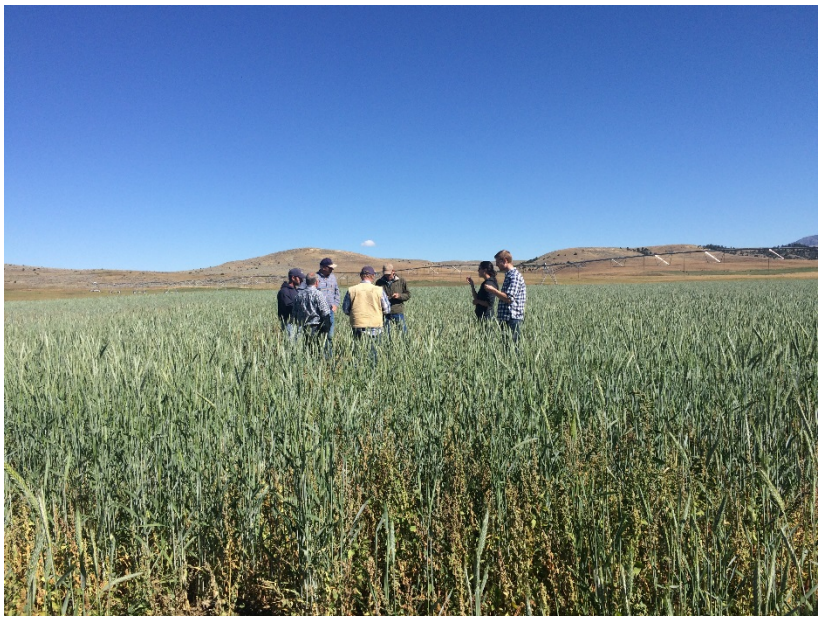


Fig. 1. Cover crop on September 16, 2016.

Monthly Precipitation at Wilsall, MT

Wilsall	J	F	M	A	M	J	J	A	S	O	N	D	Total
15 yr avg 2002-2016	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	11.12
2015	0.54	0.37	0.54	1.79	1.89	1.07	1.61	0.45	0.84	1.61	0.92	0.83	12.46
2016	0.31	0.28	0.69	0.99	1.50	0.89	2.09	0.44	2.44	1.49	0.32	0.68	12.12

Fig. 2. Monthly precipitation at Wilsall, MT. Shields Valley AgriMet station near Wilsall, MT.

Introduction:

This was a field that has been in a grass/alfalfa mix in recent years. The producer wanted to try a multi-species cover crop in a 12 ac field to be used for grazing. The species mix would not only provide forage but also benefit the soil by introducing more broadleaf plants and warm-season grasses.

Results:

Three random clippings were taken on September 16, 2016, and dried and separated by species. There were 80 days between seeding and sampling, with 1528 growing degree days (base 40) during this same period (Shields Valley AgriMet). The average production from the clippings was 2452 lbs of dry matter per acre. Using a harvest efficiency of 50% for grazing and allowing 915 lbs/AUM results in 1.3 AUMs of grazable forage per acre or 16 AUMs for the 12 acres planted. At $30/AUM, the forage value is $39/acre.

The Shields Valley is notorious for a limited growing season with freezing conditions possible in every month of the year. Small grains and hay are the most common crops successfully grown in the valley.

Summary and Discussion:

Overall, this cover crop grew well but triticale, a cool-season grass, dominated. Triticale was only 20% of the seed mix but produced over 97% of the biomass. The effort to introduce warm season species to the field was unsuccessful for both grasses and broadleaf plants. It is unknown if this site has residual herbicide activity or low nutrient availability that affected the 2016 crop diversity. The cover crop was grazed in the fall and the producer was pleased with the results.

This cover crop is the same mix as planted in "Irrigated Cover Crop for Grazing near Wilsall," but produced only 40% of the biomass. The later planting date may have influenced this, however the plant growth stage was very similar between the two. More likely, a soil fertility issue may be at work, as the plant stand and vigor was noticeably less at this location.

Soil health-building practices have an important place in the Shields Valley but climatic conditions may dictate the mix composition that will be successful. Native rangeland in the area is dominated by cool-season plants. Consideration should be given in future cover crop mixes to limit the amount of cool-season grasses to improve plant diversity.

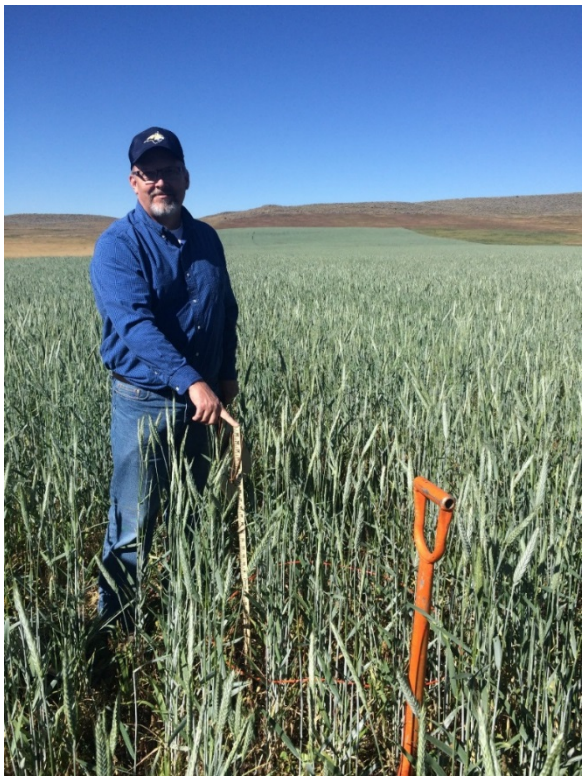


Fig. 3. Cover crop on September 16, 2016.

Cover Crop	Percent of total seed number	Dry matter production (lb/ac)	Percent of total biomass production
Spring Forage Peas (4010)	24	13	0.5
Triticale (Trical 141)	20	2396	97.7
German Millet	32	25	1.0
Turnip (Purple top)	6	19	0.8
Forage Kale (Bayou)	6	0	0
Sunflower (Peredovic)	4	0	0
Safflower (Finch)	8	0	0

Fig. 4. Cover crop seed mix and production, 2016.

Cover Crop Following Irrigated Winter Wheat Harvest near Hardin

Evan Van Order, NRCS Soil Conservationist, Hardin MT 2016

County: Big Horn
Average annual precip: 11-12”
MLRA: 58A, Northern Rolling Plains
Dominant Soil Type: Vanada Clay, 0-1% slope
Acres: 89.6
Planting Date: July 30, 2016
Seeding Rate: 667,568 seeds/acre, or 29.4 lb/acre
Seed cost: $29.15/acre (inoculant, seed, and delivery)
Seeding Method: Sunflower No-till Grain drill, Double Disk
Row Spacing: 7.5”
Tillage: No-till
Previous Crop and Year: 2016 winter wheat; 2015, Sugar Beets
Herbicides: Pre: Glyphosate
Post: N/A
Insecticides/Fungicides: N/A
Fertilizer: N/A
Irrigation: N/A
Termination Method and Date: Frost kill Nov. 15
Next Crop: Soybeans

Fig. 1. Cover crop July 28, 2016.

Monthly Precipitation at Hardin, MT

Hardin	J	F	M	A	M	J	J	A	S	O	N	D	Total
30 yr avg 1981-2010	0.46	0.43	0.75	1.33	2.06	1.76	1.22	0.70	1.20	1.08	0.54	0.43	11.97
2014	0.47	1.28	1.23	0.68	2.65	1.97	0.24	2.46	1.09	0.40	0.66	0.54	11.7
2015	0.97	0.16	0.08	1.30	2.94	3.22	1.04	0.81	0.56	1.03	0.39	0.37	12.87
2016	0.40	0.16	1.37	2.71	2.36	0.17	0.71	1.94	3.29	4.14	0.27	1.16	18.68

Fig. 2. Monthly precipitation at Hardin, MT. Western Regional Climate Center, station #243915.

Introduction:

A cover crop mix was planted following winter wheat harvest to utilize the rest of the growing season, add diversity to the cropping system, keep a living root in the soil, and increase soil organic matter. The field is 89.6 acres. Approximately 80 of those acres are irrigated by center pivot and two corners are flood irrigated. The field will be planted to soybeans in 2017. The cover crop was terminated by frost in November and residue was left in the field. No grazing of the cover crop occurred.

Results:

Winter wheat was harvested in July 2016. The cover crop was planted with no-till methods into the standing 4” winter wheat stubble, on July 30, 2016. No additional fertilizer was applied. All ten species of the mix established well and were well represented throughout the stand. On Sept. 19th, 2016 sampling was conducted on 3 clipping sites which were randomly selected across each cover crop stand. All sites were on Vananda clay soils. There were 51 growing days from the time of planting to the time of clipping. There were 1576 Growing Degree Days (base 40) from the time of seeding to the sampling date. Plants were separated by species in the field and air-dried at the

Hardin Field Office. Total aboveground biomass after air-drying was 1346 lb/acre, or 0.67 ton/acre. Assuming 910 lbs of forage per animal month, and 50% utilization rate on 89.6 acres, there were 66.3 AUMs available in this field.

Summary and Discussion:

Overall, this cover crop grew well with good biomass accumulation in the limited amount of growing days. The warm season grasses in the stand were noticably yellow in appearance, indicating a possible nitrogen deficiency. Possible causes of the nitrogen deficiency could be vigorous winter wheat growth in the previous crop that used all availble N in the soil profile. Likewise, some N could be tied-up in the wheat residue left in the field. A small portion of the field included an area that was formerly a corral, in this area the cover crop was noticably darker green in color and more vigorous in growth. In the future, producers may want to There consider applying starter fertilizer when seeding a cover crop immediately after small grain harvest.

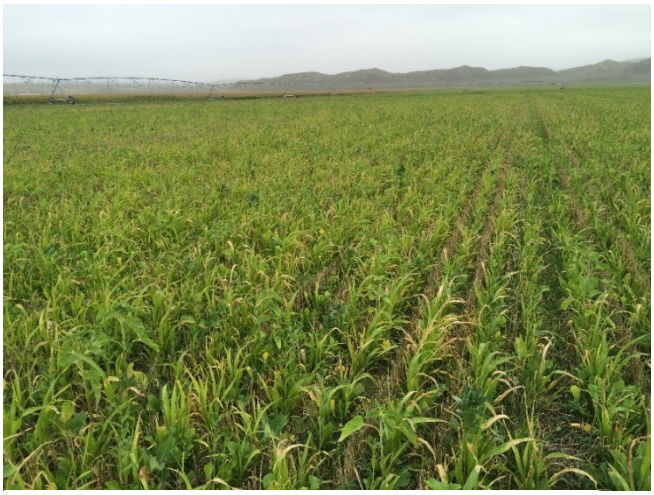


Fig. 3. Cover crop after winter wheat, Sept 21, 2016. Note yellowing, indicating potential nutrient deficiency.

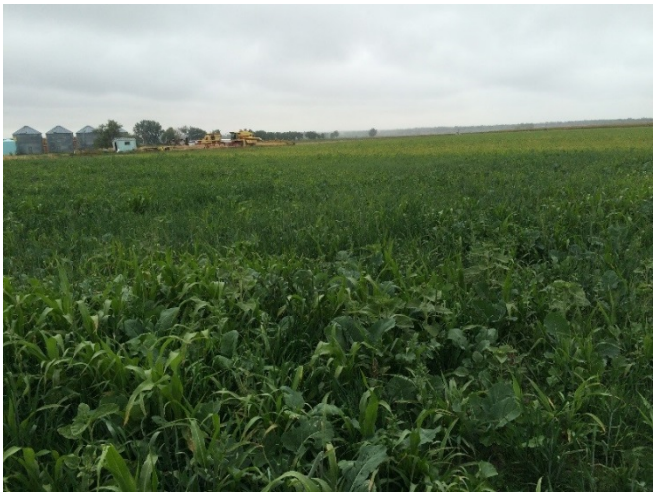


Fig. 4. The same cover crop planted in an old corral area, Sept 21, 2016. Note deep green color, indicating nutrient sufficiences. Note yellowed cover crop in background.

Cover Crop	Seed Mix %	Wheat Field Plant Biomass %	Old Corral Area Plant Biomass %
Legumes	23.4	3	5
Brassicas	19.7	33	10
Warm season grasses	41.1	29	25
Broadleaves	15.8	30	37
Cool Season Grasses	0	5	23

Fig. 5. Comparison of planned seed mix percentage vs actual aboveground biomass percentage

Forage Crop as Fallow Replacement in Dryland Winter Wheat near Hardin

Evan Van Order, NRCS Soil Conservationist, Hardin MT 2016

County: Big Horn
Average annual precip: 11-12”
MLRA: 58A, Northern Rolling Plains
Dominant Soil Type: Colby Silty Clay Loam, 4-8% slope
Acres: 100
Planting Date: June 3, 2016
Seeding Rate: 798,880 seeds/acre, or 25.7 lb/acre
Seed cost: $26.71/acre (inoculant, seed, and delivery)
Seeding Method: John Deer No-till Grain drill, Double Disk
Row Spacing: 10”
Tillage: No-till
Previous Crop and Year: 2015, Winter Wheat
Herbicides: Pre: Glyphosate
Post: N/A
Insecticides/Fungicides: N/A
Fertilizer: N/A
Irrigation: N/A
Termination Date and Method: Swathed and baled in fall
Next Crop: Winter Wheat

Fig. 1. Dryland radish, July 28,2016.

Monthly Precipitation at Hardin, MT

Hardin	J	F	M	A	M	J	J	A	S	O	N	D	Total
30 yr avg 1981-2010	0.46	0.43	0.75	1.33	2.06	1.76	1.22	0.70	1.20	1.08	0.54	0.43	11.97
2014	0.47	1.28	1.23	0.68	2.65	1.97	0.24	2.46	1.09	0.40	0.66	0.54	11.7
2015	0.97	0.16	0.08	1.30	2.94	3.22	1.04	0.81	0.56	1.03	0.39	0.37	12.87
2016	0.40	0.16	1.37	2.71	2.36	0.17	0.71	1.94	3.29	4.14	0.27	1.16	18.68

Fig. 2. Monthly precipitation at Hardin, MT. Western Regional Climate Center, station #243915.

Introduction:

Two different multi-species forage mixes were planted as an alternative to fallow on a dryland winter wheat field near Hardin, MT. The field itself is 211.7 acres. The mixes were planted on June 3 on about 100 of those acres, with the remaining acres left in fallow for comparison. Forage Mix #1 was based on millet and Forage Mix #2 was based on sorghum-sudangrass. Both forage crops were swathed and baled in the fall, prior to winter wheat seeding in November.

Results:

Due to spring rains the soil moisture profile was full at the time of planting, the forage crops established and grew well. June was unseasonably hot and dry, stressing the cool season species in the planting. Warm season species in the mix continued good growth through the high temp/low moisture conditions. Mix #2 contained sorghum/sudangrass at 60% of the total seed mix. The Sorghum-sudan grew very well, however there was a noticeable lack of vigor in the other species seeded in this mix suggesting that the allelopathic effect of sorghum/sudangrass can reduce species diversity in the mix. In contrast, Forage Mix #1 contained millet species with no sorghum-sudangrass and contained much more plant species diversity in the final forage.

On Sept. 19th, 2016 sampling was conducted on 2 clipping sites per cover crop mix that were randomly selected across each cover crop stand, all sites were on Silty Clay Loam soils. There were 108 growing days from the time of planting to the time of clipping. There were 3525 Growing Degree Days (base 40) from the time of seeding to the time of sampling. Plants were separated by species in the field and air-dried at the Hardin Field Office. Total aboveground biomass after air-drying was Mix #1: 3583 lb/acre, or 1.79 ton/acre, Mix #2: 3754 lb/acre, or 1.9 ton/acre. Assuming 910 lbs of forage per animal month, and 50% utilization rate on 100 acres, there were 98.4 AUMs for Mix #1 and 103.1 AUMs for Mix #2 for a total of 201.5 AUMs available in this field.

Summary and Discussion:

Overall, this cover crop grew well with good biomass accumulation. The stand was healthy with very little weed pressure. Notice that 2016 was a wet year, with 64% more precipitation than the 30 year average. This certainly made a difference in the success of this dryland biomass production and should help offset any possible soil moisture loss when compared with fallow. In a normal precipitation year, production would not have been as vigorous, and soil moisture depletion could affect the subsequent wheat crop. Planting this mix a little earlier in the year (last week of May) might have given the cool season species a better opportunity to produce more biomass. Spring rains and a lack of available labor prevented an earlier planting in this instance. The producer was very pleased with the forage production, as he was able to produce forage on land that otherwise would have been fallow.

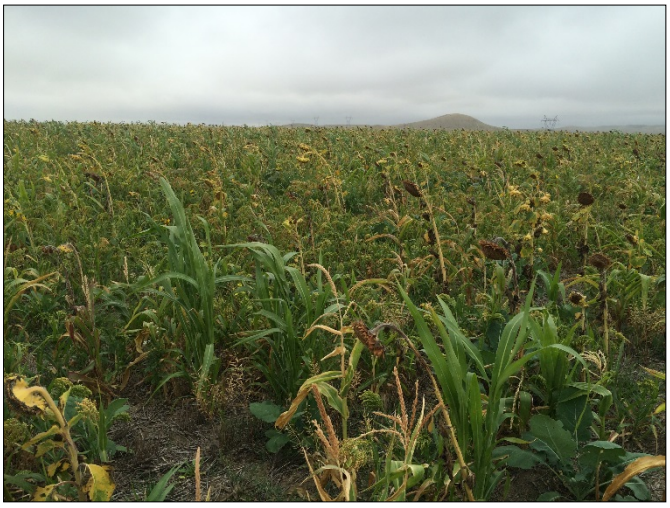


Fig. 3. Mix #1, Sept 21, 2016. Notice plant species diversity.

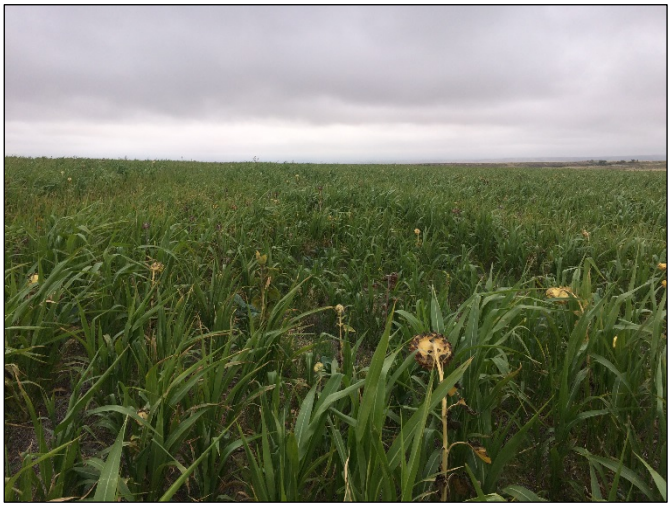


Fig. 4. Mix #2, Sept 21, 2016. Notice lack of species diversity.

Cover Crop	Mix #1 Percent of Total Seed #	Mix #1 Plant Biomass %	Mix #2 Percent of Total Seed #	Mix #2 Plant Biomass %
Legumes	6	3	24	3
Brassicas	16	10	15	2
Warm season grasses	75	66	60	90
Broadleaves	2	21	1	5

Fig. 5. Comparison of planned seed mix percentage vs actual aboveground biomass percentage